INSTRUCTION MANUAL

B&K PRECISION

MODEL 510B TRANSISTOR TESTER

B&K PRECISION

MODEL 520C SEMICONDUCTOR TESTER

TEST INSTRUMENT SAFETY

WARNING!

An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. High voltages pose an even greater threat because such voltages can more easily produce a lethal current. However, voltage as low as 35 volts DC or AC RMS should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. Be alert to the following hazards when using the Model 510B or 520C:

1. When performing in-circuit testing of semiconductors, make sure power is removed from the circuit under test. For "hot chassis" equipment, disconnect the power plug in addition to turning off the on-off switch. Most recent television sets, audio equipment, and other equipment with a 2-wire power cord are transformerless "hot chassis" powered, where one side of the AC power line connects directly to the chassis. If such equipment does not have a polarized power plug to prevent insertion the "wrong" way, a serious shock hazard exists if the chassis is touched. Additionally, damage to the semiconductor tester or the equipment under test could result. Unplug any such equipment from its AC outlet; just turning off the on-off switch does not eliminate the hazard. To be on the safe side, treat all equipment as "hot chassis" unless you are sure it has an isolated chassis or an earth ground chassis.

2. Only qualified electronics technicians who are trained to work safely in the presence of high voltage should perform servicing of these testers.

INSTRUCTION MANUAL FOR

MODEL 510B TRANSISTOR TESTER

MODEL 520C SEMICONDUCTOR TESTER

B&K PRECISION®
1031 Segovia Circle • Placentia, CA 92870

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INTRODUCTION

The B & K Precision Model 510B Transistor Tester and Model 520C Semiconductor Tester are designed for in-circuit and out-of-circuit transistor testing, with special features for making additional tests on devices out-of-circuit.

Both instruments use both a high-current, low duty-cycle pulse technique to test transistors in the presence of shunting circuitry, and a low-current drive system which enables the user to identify the terminals of the device in most in-circuit tests and all out-of-circuit checks.

The instruments are designed for a minimum amount of control manipulation, making for rapid testing of most devices.

A 9V alkaline battery is supplied with the instrument and must be connected prior to use.

SPECIAL FEATURES

Model 510B and Model 520C

1. Patented limited-energy pulse circuit permits highly successful use of in-circuit testing in the presence of low shunt impendances with complete safety for the device under test.
2. A human-engineered panel design which eliminates the need for reference to the operating manual – only three switches, no panel adjustments.
3. Six-position TEST switch sequentially connects the device being tested in all possible configurations, making it unnecessary to know the device terminal identification. Can be left in GOOD position so that additional tests can be made without memorizing test position.
4. Base or gate lead identified by color as TEST switch is operated when testing with HI drive. All leads of transistor are identified when testing with LO drive.
5. Automatic polarity indication to identify NPN or PNP type devices.
6. Clip-on test leads that make positive connections to devices in difficult locations. Free operator's hands to make further tests.
7. Choice of test leads or front panel socket for out-of-circuit tests.
8. Optional battery or adapter instrument power.
9. Power down mode when operated from 9V battery.

10. Audible momentary tone tells when the device under test is good – no need to take eyes off circuit board while testing hard-to-get-at devices.

Model 520C Only

1. Logarithmic leakage LEDs which display a wide leakage current range. When the leakage current is less than .1 μA (approximately 0) and the leakage/identify switch is in the "Leakage" position, the number 1 LED and the X.1 μA LED will blink.

SPECIFICATIONS

Model 510B and Model 520C (except as noted)

IN-CIRCUIT:

GOOD/BAD test for transistors, FETs or SCRs.
Identifies transistor as NPN or PNP and FET as N or P channel.
Identifies gate lead of FET or base lead of transistor (HI drive).
Identifies all leads of transistor when using LO drive.
Identifies all leads of SCRs.
Identifies SILICON or GERMANIUM transistors. (Model 520C only)

OUT-OF-CIRCUIT:

GOOD/BAD test for transistors, FETs or SCRs.
Identifies transistor as NPN or PNP and FET as N or P channel.
Identifies gate lead of FET by test lead color.
Identifies all leads of transistor or SCR by test lead color.
Measures reverse LEAKAGE from .1 μA to 9 mA. (Model 520C only)
Measures I_{DSS} and gate leakage of FETs. (Model 520C only)
Identifies SILICON or GERMANIUM transistors. (Model 520C only)

APPLIED TEST CURRENTS:

Base Drive: 220 mA (HI drive) or 1 mA (LO drive) at 8% duty cycle.
Collector Drive: 110 mA at 8% duty cycle.
Test Repetition Rate: 10 per second.
Reverse Voltage for leakage test: 2.0V. (Model 520C only)

LIMITING IN-CIRCUIT SHUNT VALUES FOR VALID GOOD/BAD TEST:

Resistance:	Down to 10 ohms with HI drive.
	Down to 1.5K ohms with LO drive.
Capacitance:	Up to 15 mfd with HI drive.
	Up to .3 mfd with LO drive.

ACCESSORIES:

Three test leads with mini-lock clips supplied.

SIZE: 7.5" x 4.0" x 2.0"

WEIGHT: 1 lb.

POWER REQUIREMENTS: 9 VDC alkaline battery (supplied disconnected) or 9 VDC AC/DC adapter (optional).

BRIEF SUMMARY OF WHAT THE INSTRUMENTS WILL DO

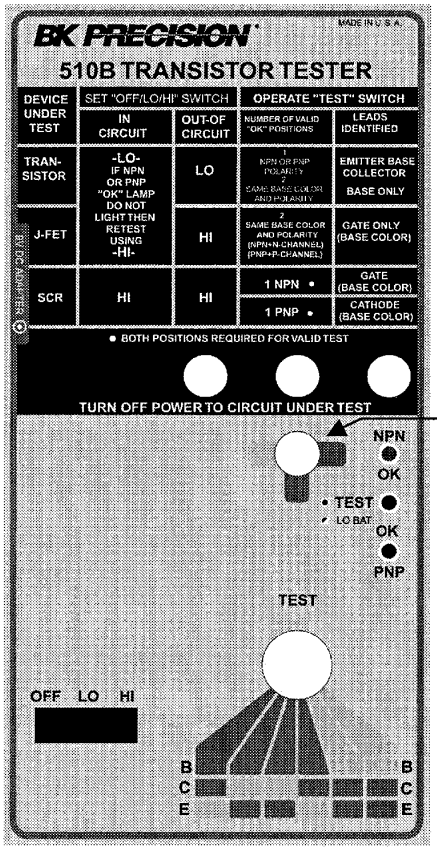
Model 510B and Model 520C

1. Determines good or bad transistors, FETs or SCRs, in or out-of-circuit.
2. Determines good or bad diodes in or out-of-circuit.
3. Identifies Emitter-Base-Collector leads of transistors.
4. Identifies gate lead of FETs.
5. Indicates polarity of good devices (NPN or PNP; N or P channel).
6. Identifies Cathode-Gate-Anode leads of SCRs.
7. Determines whether device is transistor, FET or SCR.

Model 520C only

1. Indicates whether SILICON or GERMANIUM.
2. Measures I_{CES} or I_{BES} of transistors.
3. Measures I_{DSS} and gate leakage of FETs.
4. Measures reverse leakage current of diodes.

Note: When power switch is first turned on, LEDs will cycle on then off allowing a visual check of LED function.



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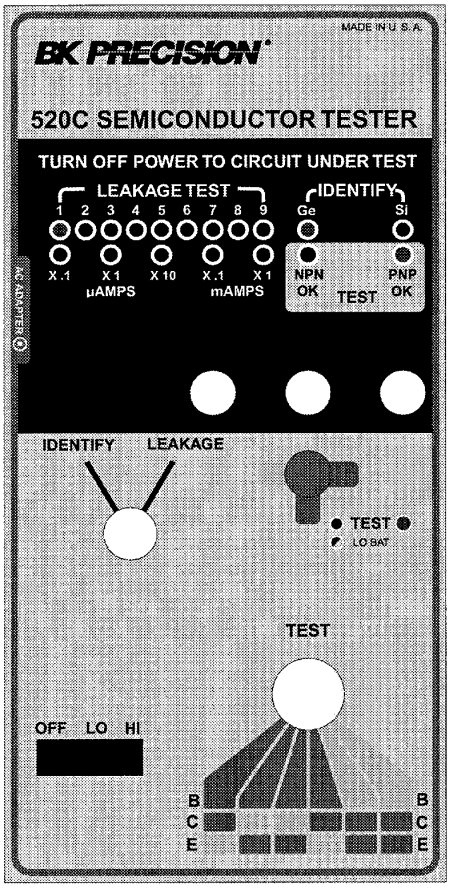
MODEL 510B CONTROLS AND INDICATORS

1. POWER ON/DRIVE Switch: Applies power to unit and selects drive power level.
2. POWER ON LED: Indicates power is on.
3. TEST Switch: Selects proper device connection for testing and lead identification.
4. NPN and PNP Lamps: Indicate polarity of good devices.
5. BANANA JACKS for Clip Leads: Enables either in-circuit or out-of-circuit testing.
6. TRANSISTOR Socket: Enables out-of-circuit testing.
7. AUDIBLE TONE: Two-second tone indicates good device.
8. ADAPTER JACK: For external 9 VDC adapter connection.
9. LEAD IDENTIFICATION INDICATOR: Indicates lead type at test socket.



10 6 5 7 11 8 9 4 2 3 1 12

MODEL 520C CONTROLS AND INDICATORS

1. POWER ON/DRIVE Switch: Applies power to unit and selects drive power level.
2. POWER ON LED: Indicates power is on.
3. TEST Switch: Selects proper device connection for testing and lead identification.
4. FUNCTION Switch: Spring-return switch selects either of two additional tests:
   a. I_{CES} or I_{BES} for transistors; I_{DDS} and gate leakage for FETs.
   b. Identifies device material (silicon or germanium).
5. LEAKAGE Indicators: Indicates device leakage current.
   a. Indicates leakage for typical silicon and germanium transistors.
   b. Indicates I_{DSS} and gate leakage for FETs.
6. IDENTIFY Lamps: Indicate silicon or germanium device.
7. NPN and PNP Lamps: Indicate polarity of good devices.
8. BANANA JACKS for Clip Leads: Enables either in-circuit or out-of-circuit testing.
9. TRANSISTOR Socket: Enables out-of-circuit testing.
10. AUDIBLE TONE: Two-second tone indicates good device.
11. ADAPTER JACK: For external 9 VDC adapter connection.
12. LEAD IDENTIFICATION INDICATOR: Indicates lead type at test socket.

HINTS AND KINKS

IDENTIFYING TRANSISTORS AND DIODES

1. Nearly all germanium transistors come in metal cases, either the tubular type with flexible leads, or in the standard TO-5 package.

2. Power transistors in stud packages or in the TO-5 or TO-3 can be either germanium or silicon, depending on age. Two and three digit 2N-numbers are mostly germanium.

3. The TO-66 power transistors and the plastic power tab packages are nearly always silicon. The collector is usually, but not always, connected to the mounting tab and the center lead.

4. The base lead of most modern plastic type transistors is either the center lead or the right hand lead when facing the flat side with the leads down. In the latter case the collector lead is in the middle.

5. Most plastic FETs have the gate lead in the right side when facing the flat side with the leads down, and the source in the middle, but there are exceptions. With nearly all junction FETs, the source and drain can be interchanged with no adverse effects.

6. All transistors will have some gain with the collector and emitter leads interchanged, with the exception of Darlingtons.

7. Germanium signal diodes can usually be recognized by their transparent hollow glass cases with either three or four color bands, or type numbers printed on them. Silicon diodes are usually painted because silicon is light-sensitive and must be protected from ambient light. The "moose" types, such as the stud package, can be either germanium or silicon.

THINGS TO KNOW ABOUT THE TESTERS

1. There are certain semiconductor devices that look like transistors which the instrument cannot test. These include: Triacs, diacs, and diode arrays.

2. In HI drive, most transistors that test good will do so in *two* adjacent TEST switch positions. This is because transistors have some gain when the collector and emitter are interchanged. If the circuit is heavily shunted, or the "reverse beta" of the transistor is very low, the transistor will test good in only *one* TEST switch position. In either case, the transistor can be considered good.

3. In LO drive, most transistors that test good will do so in only *one* TEST switch position. In some rare cases, high-frequency transistors or transistors with higher than usual "reverse beta" may test good in *two* adjacent TEST switch positions having the same BASE color in the Lead Identification Indicator. This is still a valid good test, but only the base lead of the transistor can be identified.

4. FETs can be tested in either LO of HI drive, but only FETs with a high G_m will test good in LO drive. Therefore, to insure a valid good/bad test for all junction FETs, the DRIVE switch should be set to Hi when the device being tested is known to be an FET. The tester detection circuit is more sensitive in the HI drive position.

5. POWER DOWN MODE. When operating from a 9VDC battery, the tester will power down to conserve battery life if no transistor testing is detected for five minutes. When this occurs, the TEST LED will blink every two seconds. To get out of this Power Down Mode, turn the unit power switch off then back on. The Power Down feature is disabled when using the AC/DC adapter.

6. LOW BATTERY INDICATOR. If the LEST LED blinks at a rate of about two per second, the battery voltage is low and must be replaced with a 9V alkaline battery.

USING MODEL 510B AND MODEL 520C

IN-CIRCUIT TESTING

WARNING!
Make sure all power is turned off in the circuit being tested, and that all capacitors are discharged.

A. Transistors/FETs

1. Set the DRIVE switch to the LO position.
2. Connect the three test leads in any manner to the three leads of the device you wish to test.
3. Move the TEST switch slowly through its six positions or until the tone is heard. One of the two red lamps will glow indicating whether the device is NPN or PNP, or N or P channel (the NPN lamp will glow if the FET is N channel and the PNP lamp will glow if the FET is P channel). In LO drive, most transistors that test good will do so in only *one* TEST switch position (see THINGS TO KNOW ABOUT THE TESTERS). In the TEST switch position, all the leads of the transistor can be identified as shown in the Lead Identification Indicator. Most FETs will test good (LO or HI drive) in *two* adjacent TEST switch positions having the same BASE color shown in the Lead identification Indicator, since practically all junction FETs are symmetrical. The BASE color indicated is the *gate* lead of the FET.
4. If no tone is heard as the TEST switch is slowly moved through its six positions, in LO drive, then the device under test is one of the following:
   a. Transistor with high leakage or very low gain (may not function properly in circuit).
   b. Device with open/shorted elements.
   c. Device with excessive circuit shunting (see SPECIFICATIONS).
   d. FET that will not test with LO drive.
5. Retest the device using HI drive, in Hi drive, most transistors that test good will do so in *two* adjacent TEST switch positions having the same BASE color shown in the Lead Identification Indicator. Only the base lead of the transistor can be identified.
6. If the device tests good using HI drive, then 4 (a) above could be true.
7. If the device does not test good in any TEST switch position, in HI drive, remove the device from the circuit and retest using OUT-OF-CIRCUIT procedures.

B. SCRs

1. Set the DRIVE switch to the HI position.
2. Connect the three test leads in any manner to the three leads of the SCR you wish to test.
3. Move the TEST switch slowly through its six positions. For most SCRs the NPN lamp glows in one test position and the PNP lamp glows in another test position having a different BASE color shown in the Lead Identification Indicator. Some medium and high voltage SCRs may give only an NPN indication.
4. The SCR is good if an NPN indication is obtained. The additional PNP indication, if obtained, merely confirms that the device is an SCR rather than a transistor.
5. With the TEST switch in the position that gives the NPN indication, lead identification is thus: base color is gate lead, emitter color is cathode lead, and collector color is anode lead.
6. If the SCR tests bad, then is should be removed from the circuit and tested again (may be subject to excessive shunting in-circuit).

C. Diodes/LEDs

Connect the blue and yellow test leads across the diode. Test for LEAKAGE in left most and next positions (GREEN BASE) of TEST switch. One position will read >1mA, while the other will give a lower reading depending on the shunting effect of the circuitry. If both positions produce high readings, the diode is either shorted or heavily shunted by low resistance circuitry; for example, a transient suppressor diode across a relay or solenoid coil. In this case the diode should be disconnected from the circuit and retested.

D. "Hands Off" Testing

When the base lead of devices being tested can be identified, leave the test switch in the left most position. The transistors can

then be probed one by one by connecting the green lead to the base, and the blue and yellow leads to the collector and emitter respectively. The audible tone will tell you when the transistor is good. Occasionally, the collector and emitter leads may have to be interchanged to produce a tone.

The "Hands Off" method is useful when it is necessary to test a number of transistors in a circuit, or when it is impossible to connect all three leads to the device being tested: If one lead can be clipped on the device, both hands are free to probe the remaining two leads.

E. Intermittent Testing

Often the tester can be used to identify intermittent transistors in a circuit. Connect the test leads to the suspected transistors and move the TEST switch until the tone is heard. Then, leaving the tester in this position, the transistor can be subjected to various physical tests such as tapping, heating, or cooling. An intermittent transistor will show up as an intermittent LED (NPN or PNP) and/or tone.

HINT: A can of "Instant Cold Spray" is quite useful for providing rapid cooling of discrete components.

OUT-OF-CIRCUIT TESTING

A. Transistors

Model 510B and Model 520C

1. Set the DRIVE switch to the LO position.
2. Connect the three test leads to the device or plug it into the convenient test socket on the tester (no need to worry about lead identification).
3. Slowly move the TEST switch until the tester indicates a good transistor and produces an audible tone. Leave the TEST switch in this position and identify all the leads of the transistor by the colors shown in the Lead Identification Indicator. In LO drive, the transistor should test good in only *one* TEST switch position (see "THINGS TO KNOW ABOUT THE TESTERS").
4. If no tone is heard as the TEST switch is slowly moved through its six positions, in LO drive, then the device under test is one of the following:
   a. Transistor with high leakage or very low gain (may not function properly in-circuit).
   b. Transistor with open/shorted elements.
   c. Device is an FET. If this can be verified from available service information, retest as outlined below.
   d. Device is a power Darlington which requires high base voltage. If this can be verified from service information available, retest using HI drive.
5. A transistor which tests *good* can be further evaluated for leakage and material identification.

Model 520C Only

1. LEAKAGE TESTS. Set DRIVE switch to HI. Move the TEST switch to a position that produces a good indication and turn the function switch to LEAKAGE and note the meter indication. Hold the function switch in LEAKAGE position and move the TEST switch to the other position which displays the same BASE color in the Lead Identification Indicator. The leakage should be about equal in both TEST positions and within the limits shown below. In one of the positions the meter indicates I_{CES}; in the other I_{BES}.

Device	Typical Leakage Current
Small signal silicon	.1 to .5 μA
Power silicon	.1 to 15 μA
Small signal germanium	.1 to 100 μA
Power germanium	.1 μA to 3 mA

2. IDENTIFICATION OF TRANSISTOR TYPES: If the type of transistor is not know, turn the function switch to IDENTIFY position and the tester will indicate whether the device is SILICON (yellow LED glows) or GERMANIUM (green LED glows).

B. FETs

1. Set the DRIVE switch to the HI position.
2. Slowly move the TEST switch until the tester indicates a good FET.
3. J-FETs will indicate good in *two* adjacent TEST positions

which have the same BASE color. (Most J-FETs are symmetrical.)

4. The BASE color shown in the Lead Identification Indicator is the *gate*.
5. If no audible tone is heard then the FET under test is defective.
6. A FET which tests *good* can be further evaluated as indicated in the following steps. (Model 520C only)
7. I_{DSS} LEAKAGE. Move the TEST switch to a position which produces a good indication, then turn the function switch to LEAKAGE. The meter will read I_{DSS}. Note that the I_{DSS} of FETs can range from a few microamperes to several milliamperes, and in some cases will read off scale on the 520C.
8. FET GATE LEAKAGE. Drain-to-gate or source-to-gate leakage of either N-channel or P-channel FETs can be tested by treating the gate junction as a diode. First, locate the gate lead by moving the TEST switch through each of its six positions until the tone is heard. The *gate* lead is the BASE color which appears in the Lead Identification Indicator. Then connect the FET gate to the blue test clip and one or both of the remaining FET leads to the yellow test clip. Move the TEST switch through the left most and next positions (GREEN BASE) and check for leakage. The leakage should be zero in one of the positions if the device is a J-FET, or both positions if it is a MOS-FET.
9. N-channel FET drain or source-to-gate leakage can be measured in another way. Leave the FET connected to the three test leads. Put the TEST switch in any position which does not indicate good. Then, holding the FUNCTION switch in the LEAKAGE position, move the TEST switch through all six positions and watch the leakage LEDs. If the device is good, the LEDs will indicate zero current in two of the six positions. P-channel FETs must be measured as diodes, as described above.
10. DEPLETION MODE FETs. Drain-to-source leakage of depletion mode FETs cannot be measured reliably by the Model 520C as this requires that the gate be reverse-biased while testing. Merely disconnecting the gate lead leaves the device subject to stray pickup and/or leakage currents, and

with the extremely high gate impedance there is no way of assuring that the gate will pinch off.

11. ENHANCEMENT MODE FETs. Enhancement mode FETs can be tested in the same way as transistors.

C. Diodes

Model 520C Only

1. LEAKAGE. Connect the blue and yellow test leads to the two ends of the diode. Hold the function switch in the LEAKAGE position while moving the TEST switch through the two green BASE positions. If the diode is good the leakage LEDs will indicate high current in one position and will indicate zero or some low value in the other. The low reading is the LEAKAGE current of the diode.
2. LEAD IDENTIFICATION. The anode and cathode leads of the diode can be identified. Connect the blue and yellow test leads to the diode leads. While holding the function switch in the LEAKAGE position, move the TEST switch to whichever of the two green BASE positions produces a high current reading. The diode *cathode* is connected to the test lead color indicated as the COLLECTOR in the Lead Identification Indicator.

D. SCRs

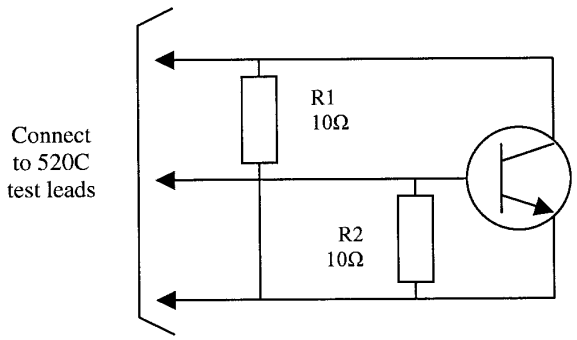
1. Set the DRIVE switch to the HI position.
2. Connect the three test leads to the SCR or plug it into the test socket on the front panel (no need to worry about lead identification).
3. Move the TEST switch slowly through its six positions. For most SCRs the NPN lamp glows in one test position and the PNP lamp glows in another test position having a different BASE color shown in the Lead Identification Indicator. Some medium and high voltage SCRs may give only an NPN indication.
4. The SCR is good if an NPN indication is obtained. The additional PNP indication, if obtained, merely confirms that the device is an SCR rather than a transistor.
5. With the TEST switch in the position that gives the NPN indication, lead identification is thus: base color is gate lead,

emitter color is cathode lead, and collector color is anode lead.

6. If the NPN lamp does not light in any test position, the SCR is defective. A "good" indication verifies that the SCR can be triggered into conduction, and in most cases this is sufficient testing. However, it is sometimes desirable to additionally test whether or not the SCRs forward blocking voltage is normal. A procedure is given at the end of this manual.

OPERATIONAL TESTS

1. To ensure that the tester is operating according to specifications, test for proper output drive power. This can be done easily by building the simple circuit in Figure 3. The tester must be switched to the HI drive position. Transistor should check good in only *one* TEST switch position.
2. To test the LO drive function of the tester, eliminate R1 and replace R2 with at 1.5kΩ resistor in Figure 3. The transistor should check good in only *one* TEST switch position.



* General purpose Transistor with a Beta of 100 or greater.

Figure 3

WARRANTY SERVICE INSTRUCTIONS

1. Refer to the MAINTENANCE section of your B & K Precision instruction manual for adjustments that may be applicable.
2. If the above-mentioned procedures do not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship PREPAID (UPS preferred) to the nearest B & K Precision authorized service agency (see list enclosed with unit).

If your list of authorized B & K Precision service agencies has been misplaced, contact your local distributor for the name of your nearest service agency, or write to:

B & K Precision Test Instruments
Factory Service Operations
1031 Segovia Circle
Placentia, CA 92870

LIMITED ONE-YEAR WARRANTY

B & K PRECISION warrants to the original purchaser that product, and the component parts thereof, will be free from defects in workmanship and material for a period or one year from the date of purchase.

B & K PRECISION will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized B & K PRECISION service contractor or the factory service department, accompanied by proof of the date of purchase in the form of a sales receipt.

To obtain warranty coverage, this product must be registered by completing and mailing the enclosed warranty registration card to B & K PRECISION, 1031 Segovia Circle, Placentia, California 92870 within 15 days from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced, or removed.

B & K PRECISION shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights that vary from state to state.

For your convenience we suggest you contact your B & K PRECISION distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to B & K PRECISION Service Department, 1031 Segovia Circle, Placentia, California 92870 properly packaged to avoid damage to shipment.

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